



Water Temperature in the Columbia and Snake Rivers

Problem Description

Water Quality Standards

Colville Confederated Tribes

Idaho

Oregon

Washington

Canadian Border

Temperature shall not exceed 16
Degrees C due to human activities.

WA and Colville WQS

Grand Coulee Dam

Temperature shall not exceed 18
Degrees C due to human activities.

WA WQS

Priest Rapids Dam

Temperature shall not exceed 20
Degrees C due to human activities.

WA WQS

OR/WA Border

Temperature shall not exceed 20
Degrees C due to human activities.

WA WQS

No measurable surface water
temperature increase resulting from
anthropogenic activities is allowed
when temperatures exceed 20
degrees centigrade (7 day running
average of the daily maximums)

OR WQS

Pacific Ocean

Salmon River

22 Degrees C Maximum
19 Degrees C Daily Average

ID WQS

No measurable surface water temperature increase resulting from anthropogenic activities is allowed when temperatures exceed 17.8 degrees centigrade from July 1 to Sept 30 and 12.8 Degrees C from Oct 1 to June 30.

OR WQS

OR/WA/ID Border

22 Degrees C Maximum
19 Degrees C Daily Average

ID WQS

Temperature shall not exceed 20
Degrees C due to human activities.

WA WQS

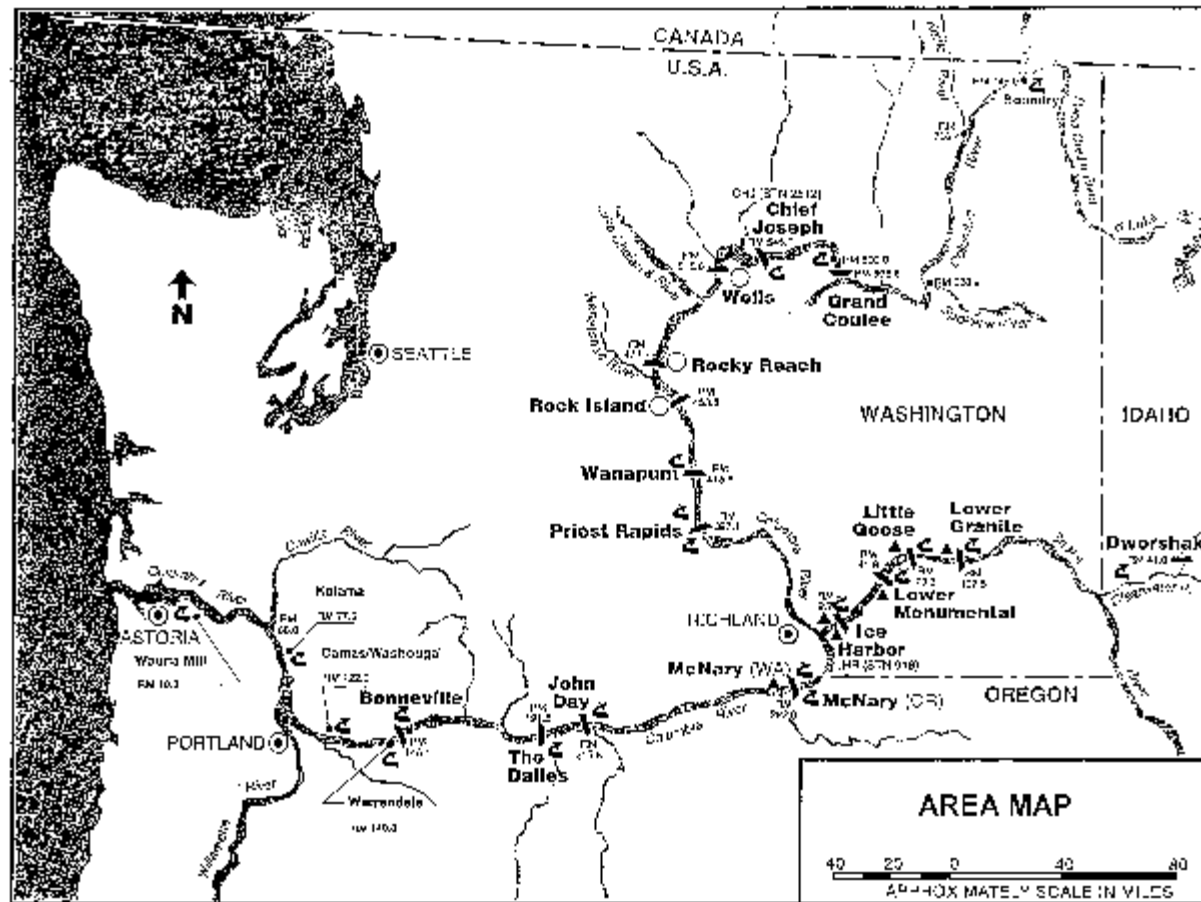
WA/ID Border

Temperature shall not exceed 20
Degrees C due to human Activities.

WA WQS

Columbia River

Area Map



Does water temperature in the Columbia and Snake Rivers exceed Water Quality Standards?

Existing Data

McKenzie and Laenen (1998) assembled temperature data from 84 stations along the Columbia and Snake Rivers within the study area.

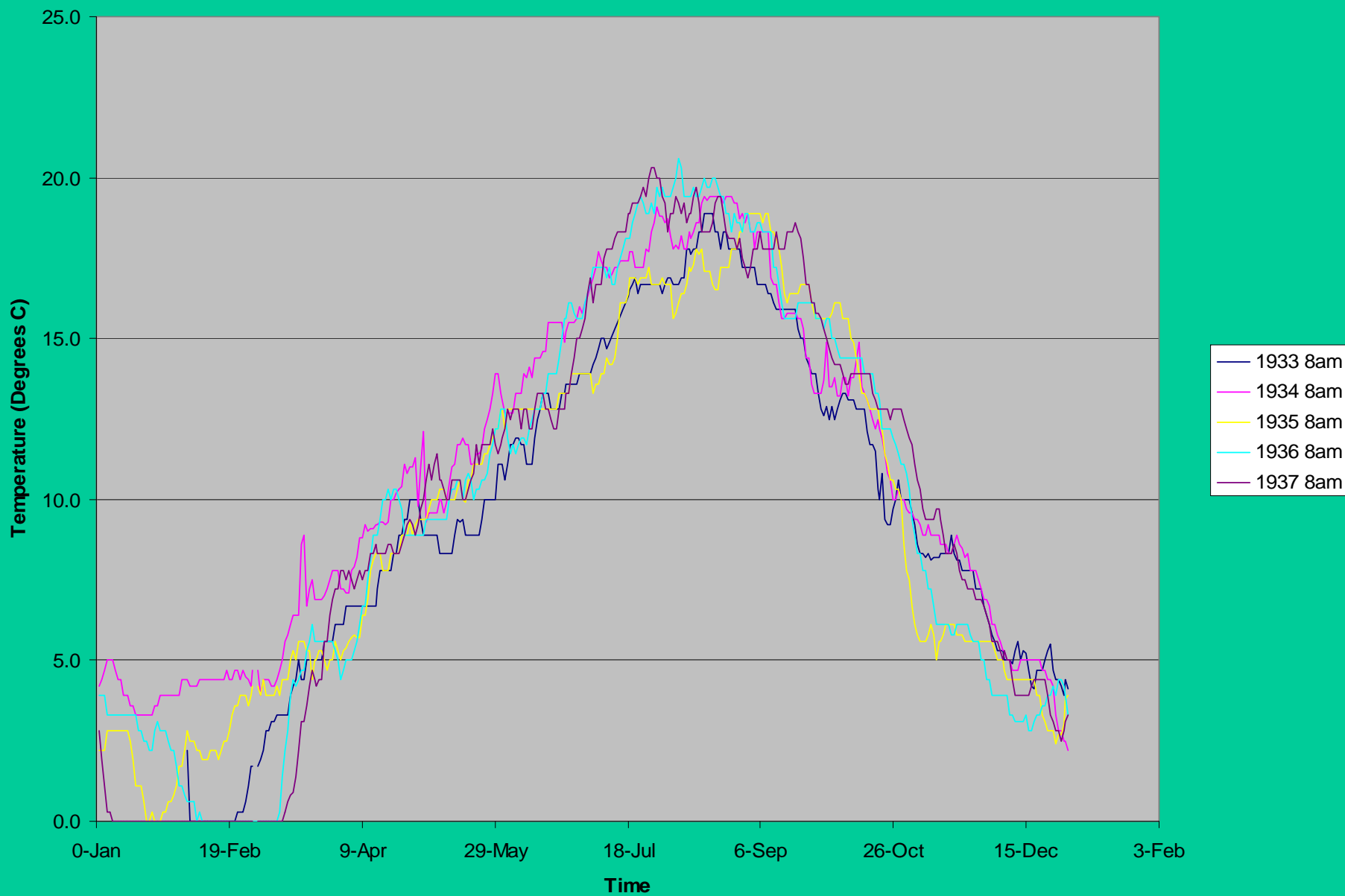
They collected data from all the dams, many USGS stations and a number of other stations.

Rock Island Dam data dates to 1933.

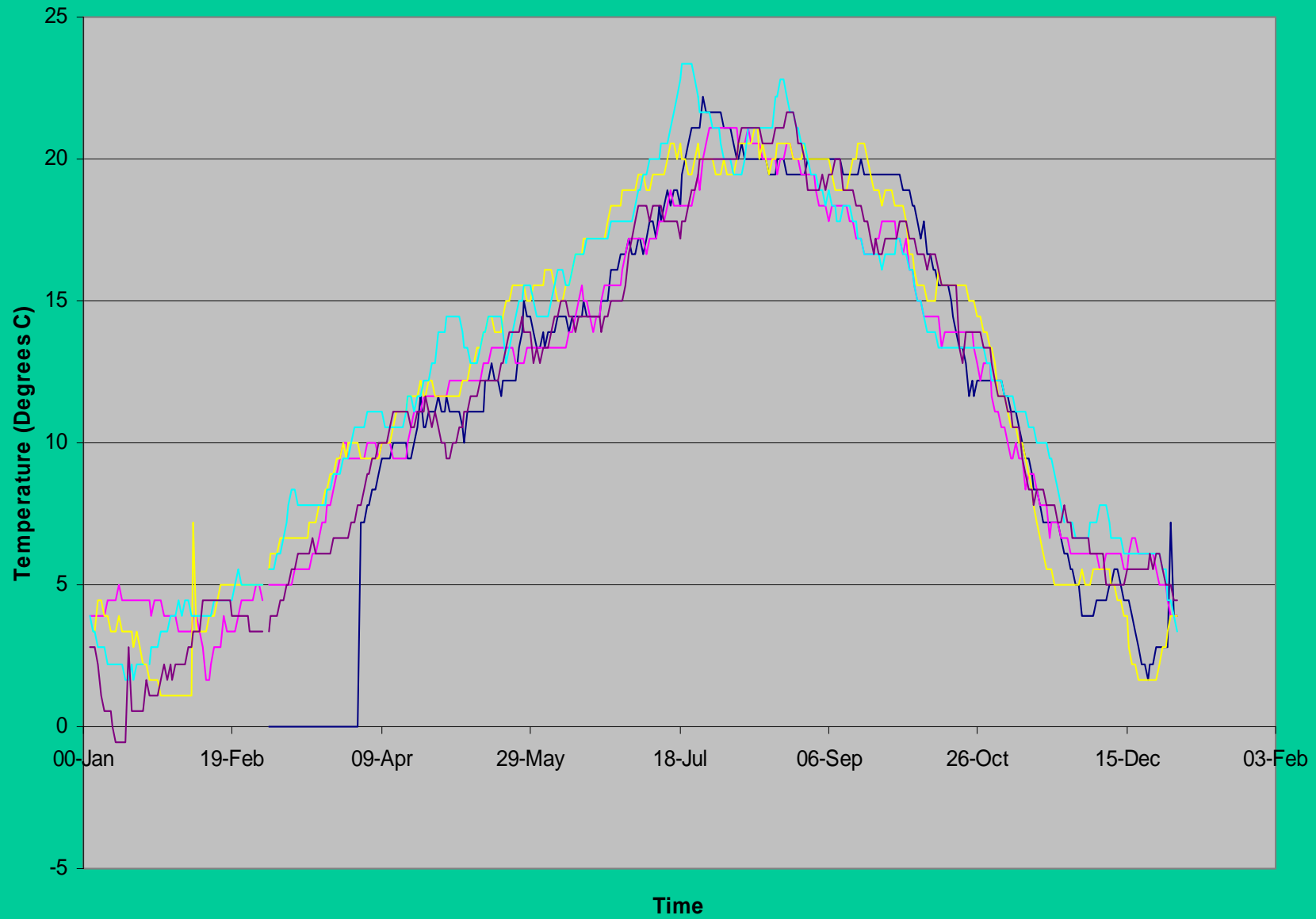
Bonneville Dam data dates to 1938.

Location	Exceeds Water Quality Criterion		Record Length
	Frequency	Magnitude	
Lower Granite Dam	0.15	2.04	5/30/88-9/17/96
Little Goose Dam	0.15	2.49	5/30/88-9/16/96
Lower Monumental Dam	0.18	2.10	5/29/88-9/17/96
Ice Harbor Dam	0.18	2.35	5/29/88-9/23/96
Wells Dam	0.10	0.87	4/18/93-9/2/97
Priest Rapids Dam	0.18	1.61	4/28/88-12/31/97
McNary Dam	0.17	1.65	4/2/85-12/31/97
John Day Dam	0.15	1.65	4/17/84-9/16/97
Bonneville Dam	0.14	1.39	4/3/86-11/2/97

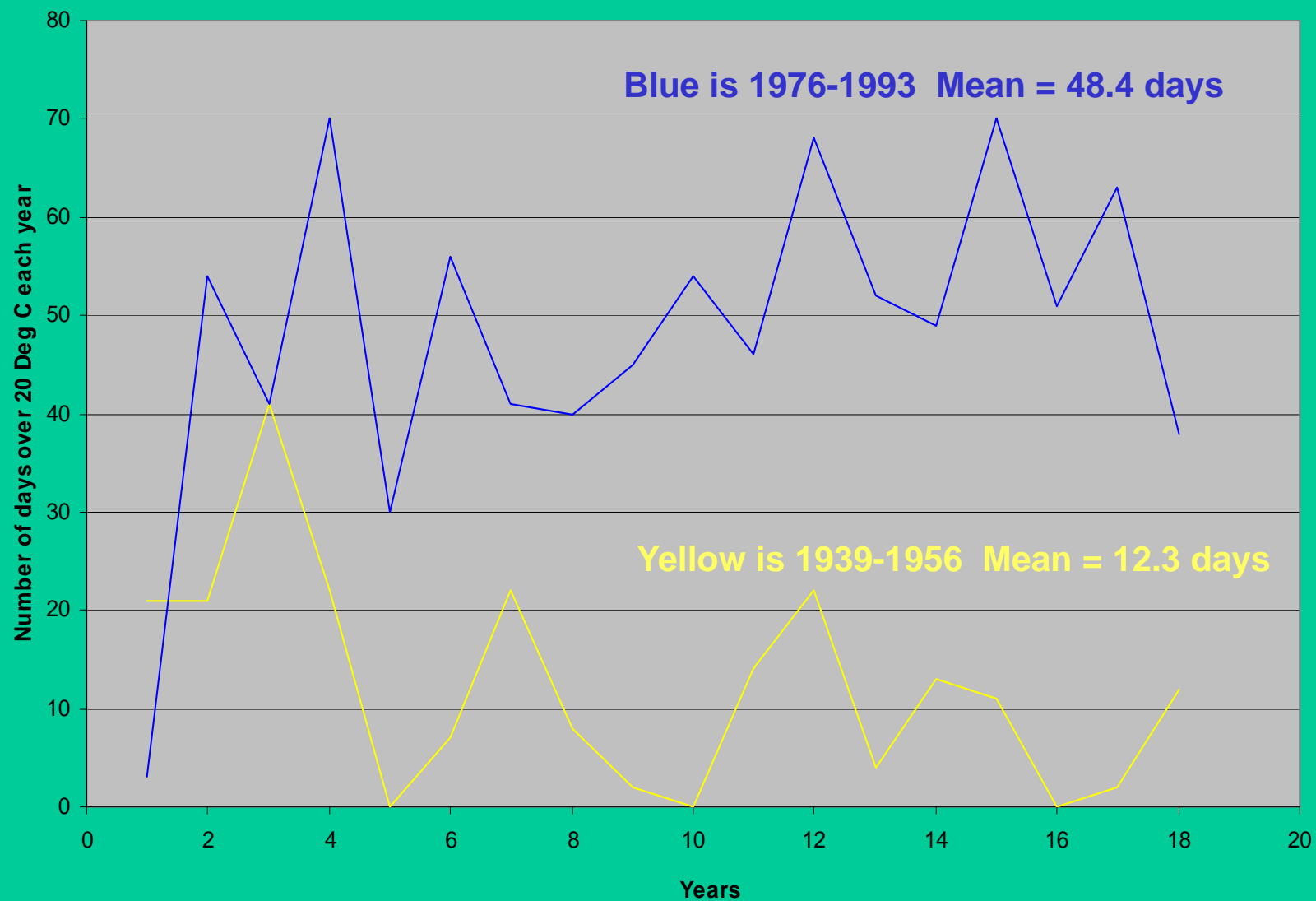
Temperature at the Rock Island Dam Scroll Case 1933 - 1937



Water Temperature at Bonneville Dam 1938 - 1942



**Number of Days that Exceed 20 Deg C at Bonneville Dam: Comparison of the two periods
1939-1956 and 1976-1993**



Frequency of Exceedance of 20 C at Bonneville Dam for the 2 periods 1939-1956 and 1976-1993

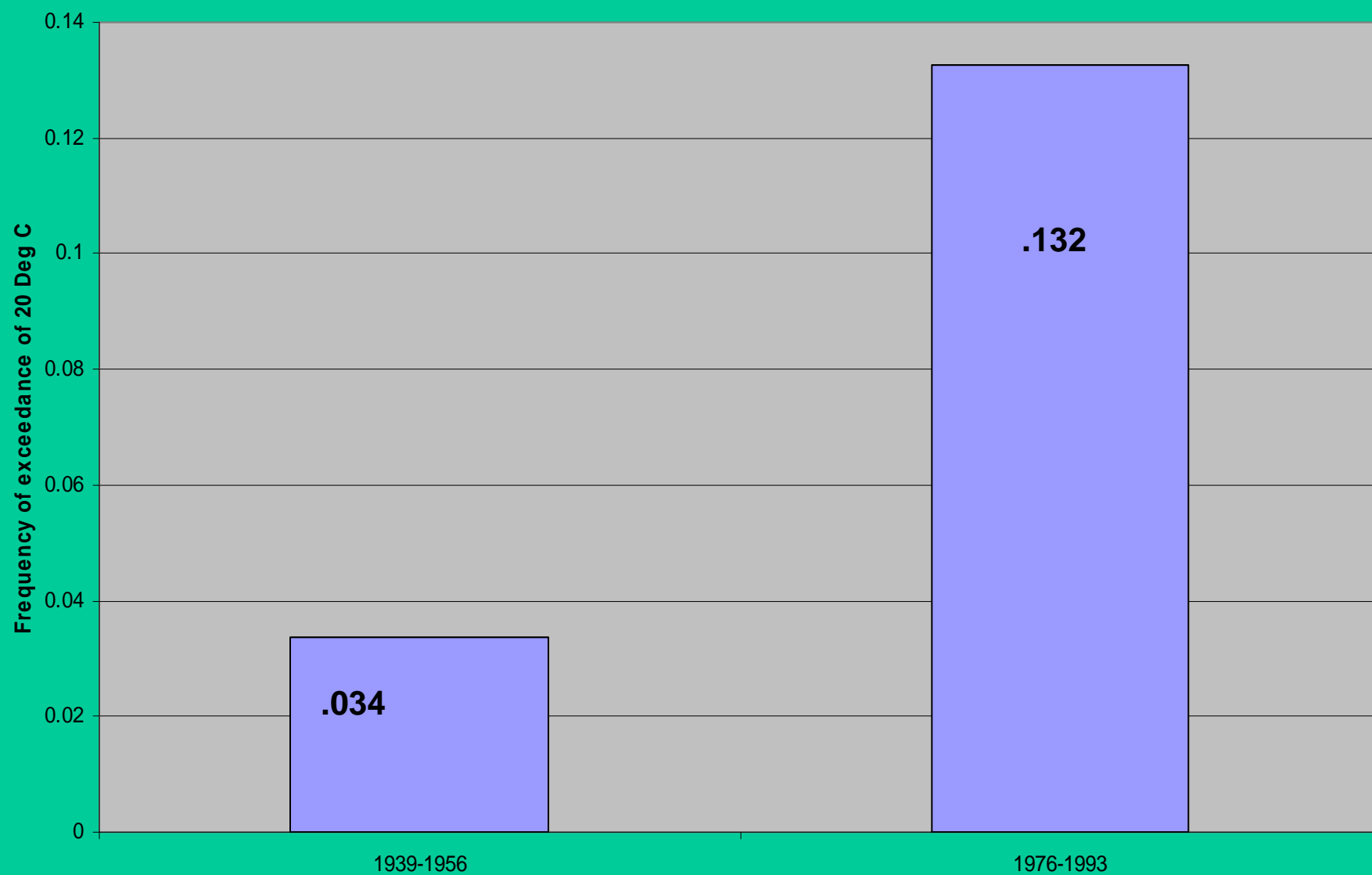


Figure 3-6 Frequency of Exceedance of 18 Deg C at Rock Island Dam 1933-1941 and 1977-1984

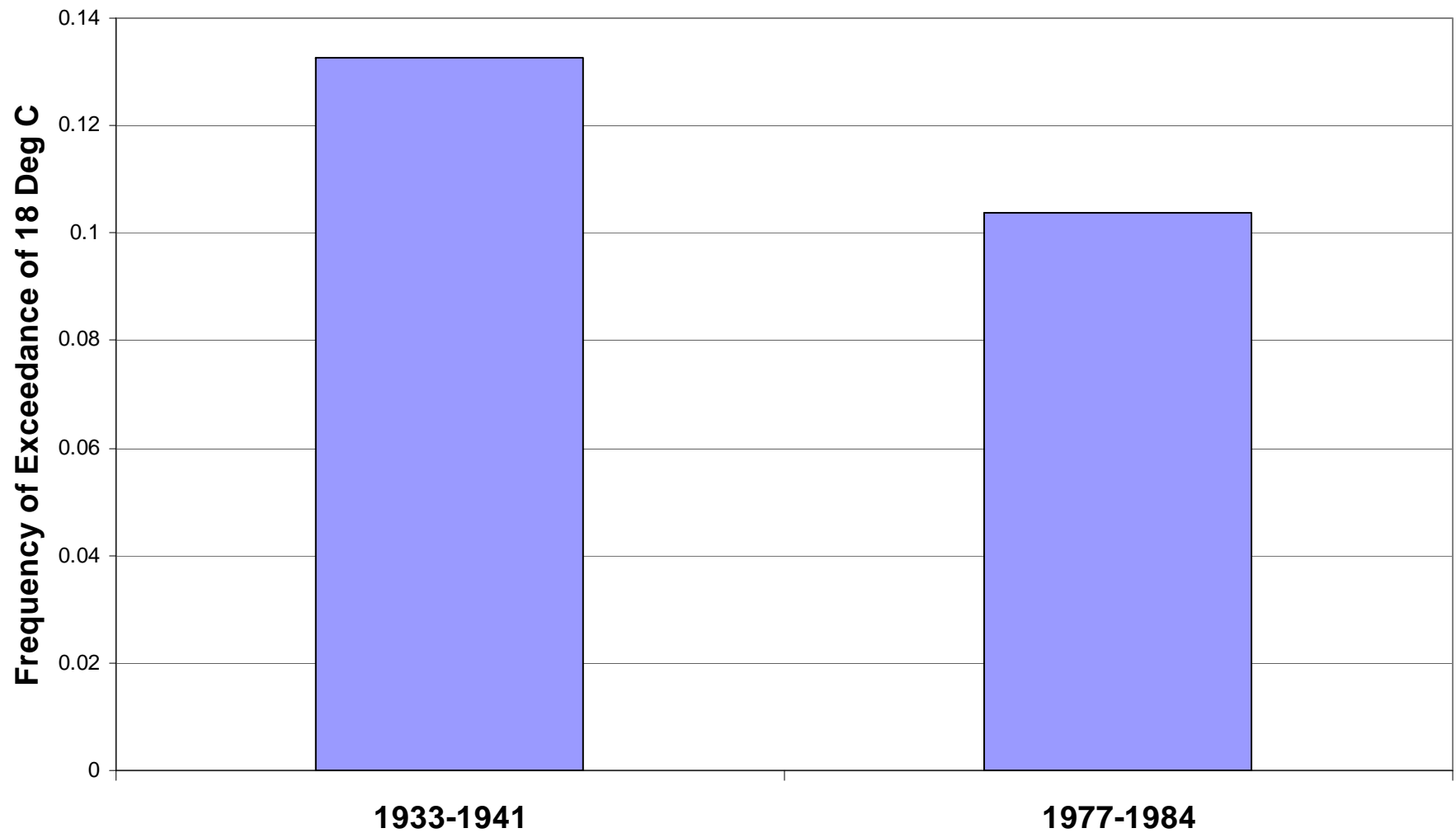


Figure 3-7 Numbers of days in which the Scroll Case Water Temperature at Rock Island Dam Exceeded 18 Deg C: 1933-1985, 1989,1990,1991,1996.

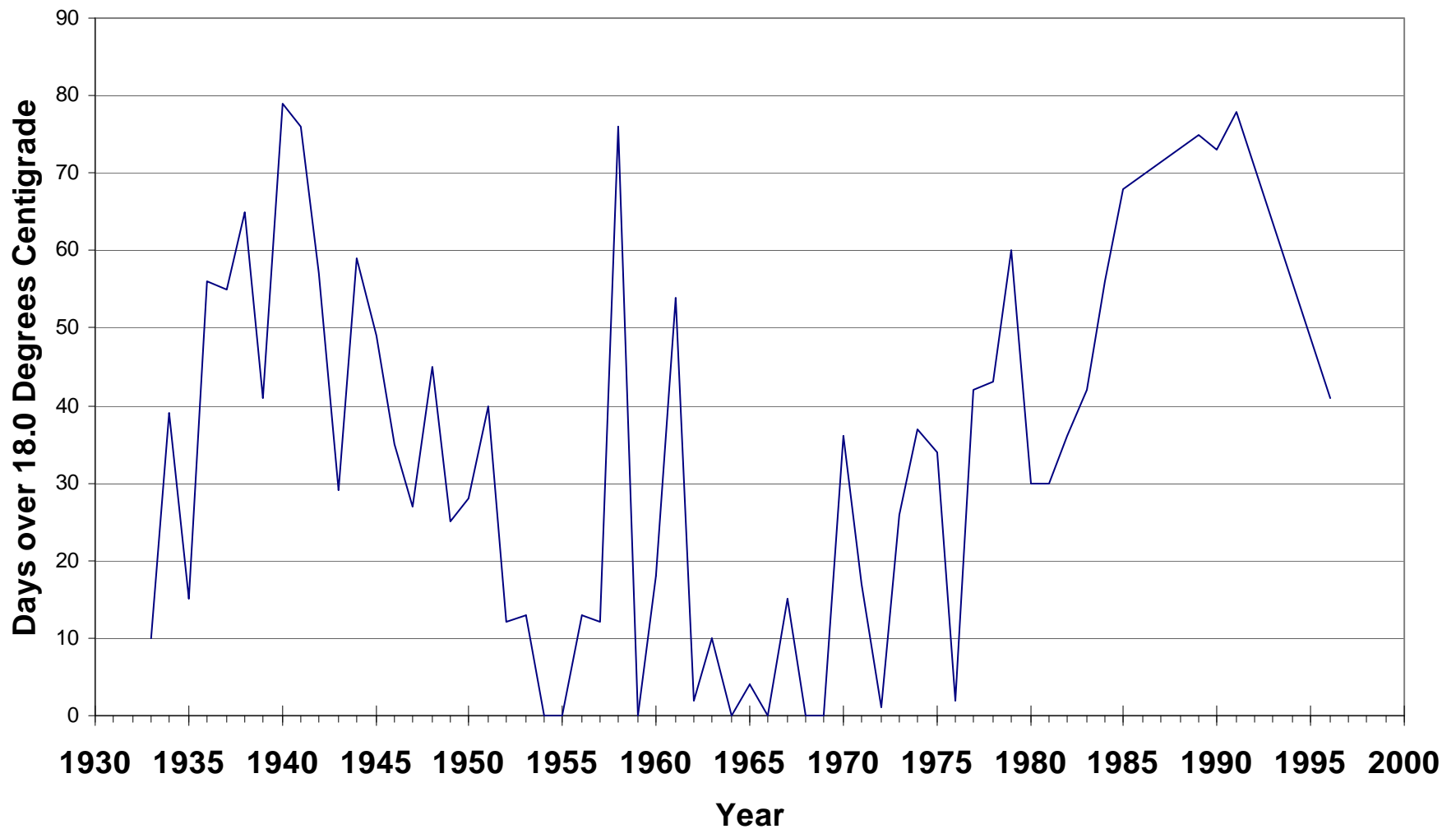


Figure 3-8 Average Weekly Air Temperature at Spokane, WA 1948-1999.

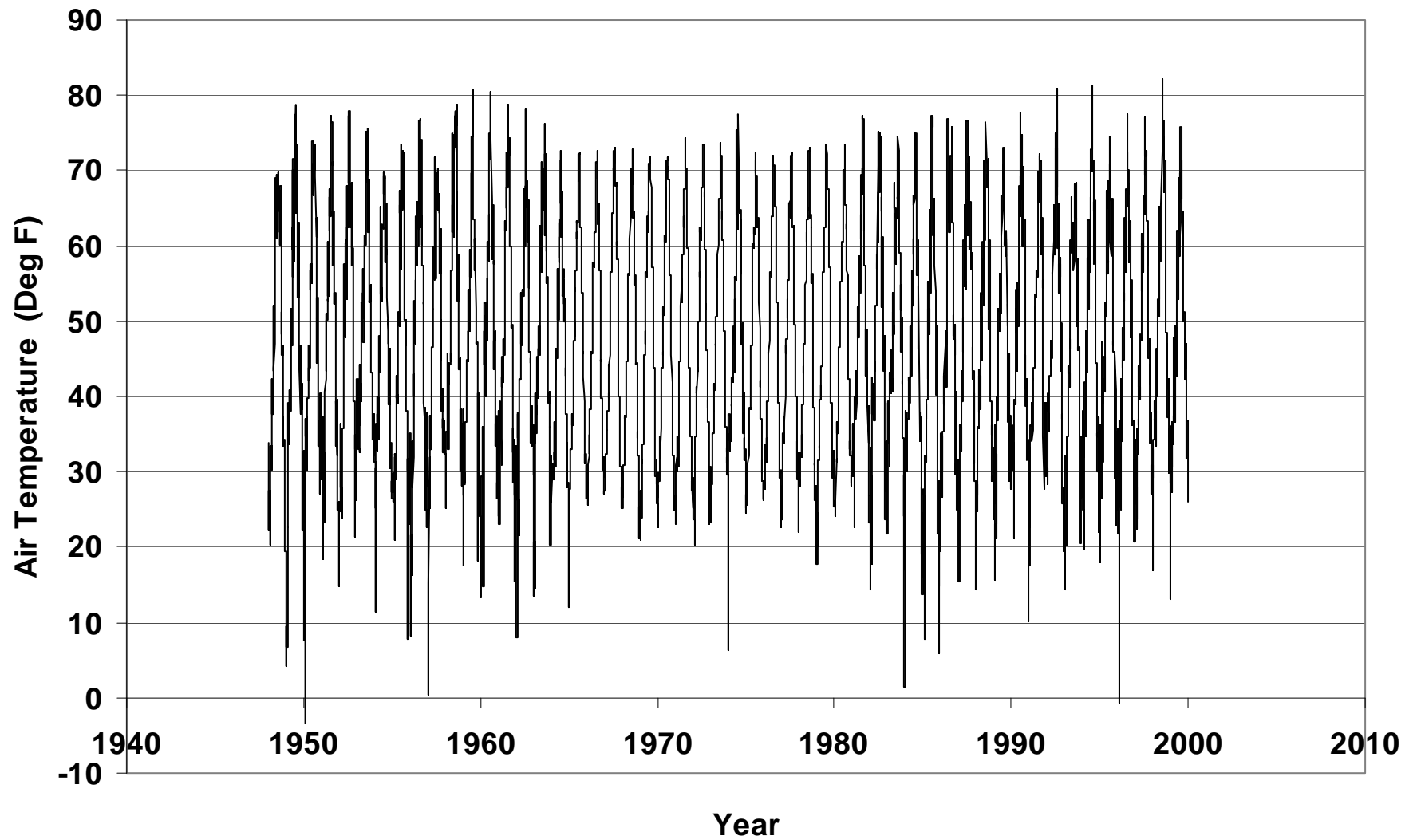
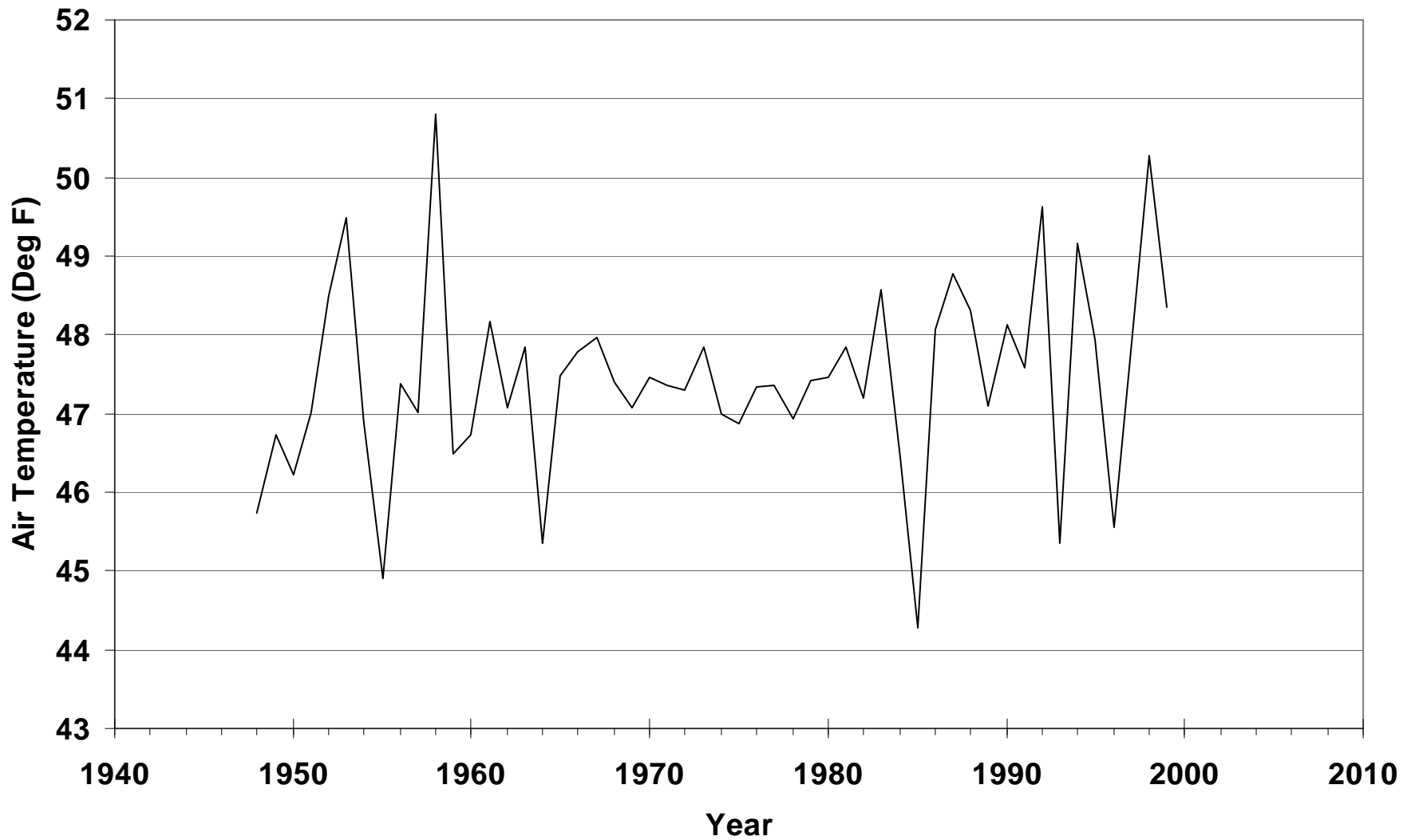


Fig 3-9 Average Annual Air Temperature at Spokane, WA 1948-1999



**Figure 3-10 Average Temperature at Spokane, WA during the Five Decades
from 1950- 1999.**

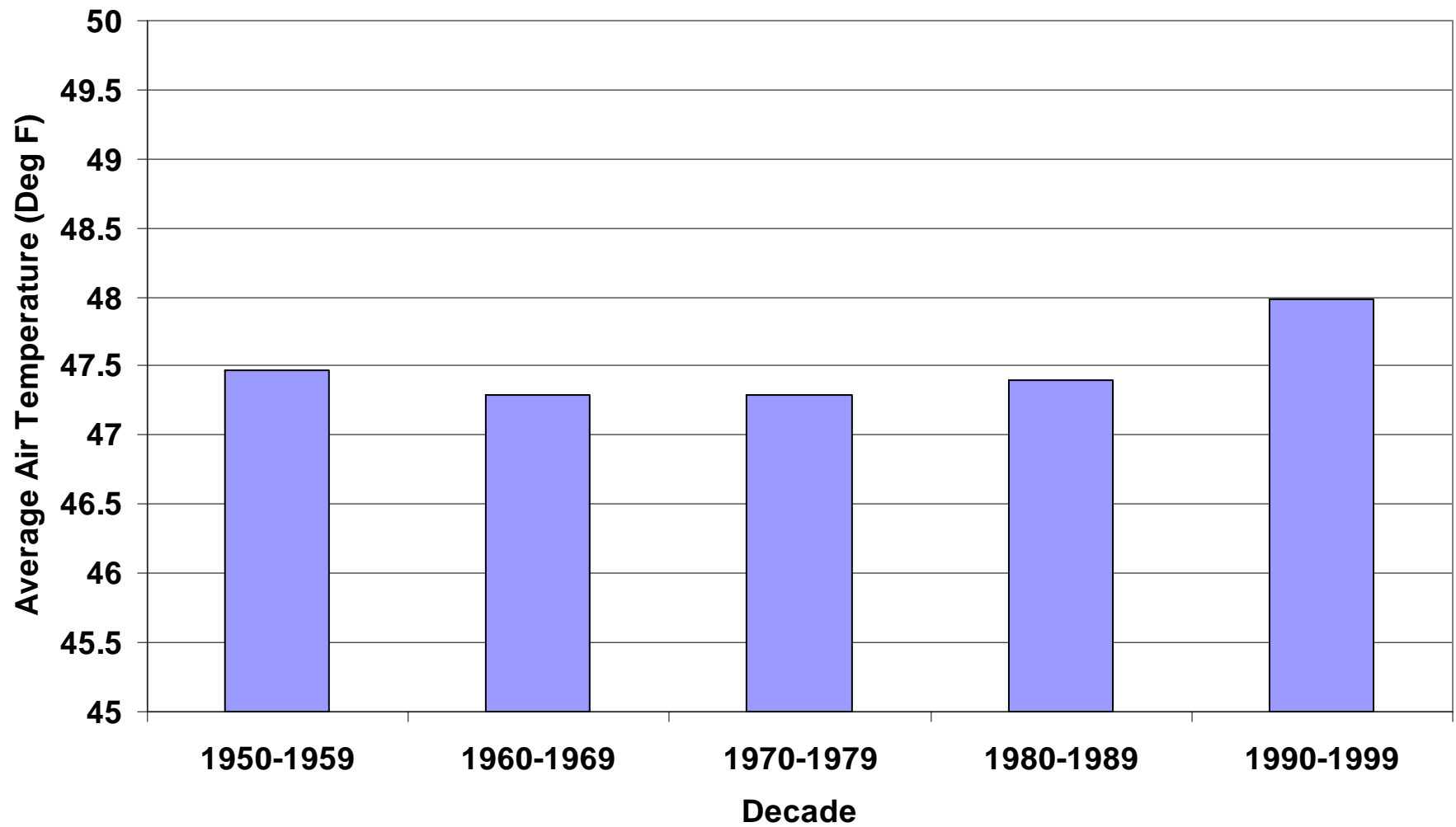


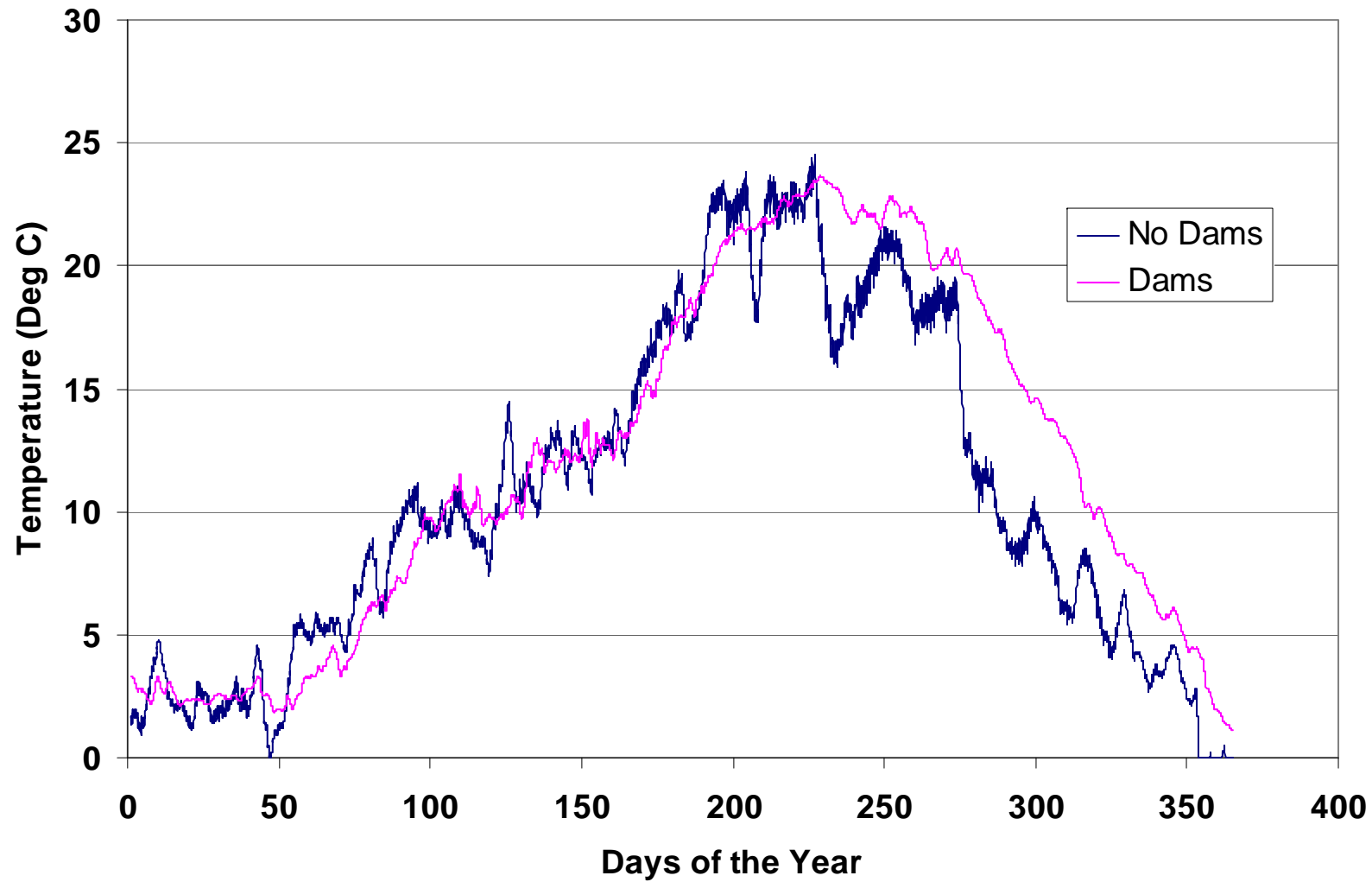
Table 3-5: Temperature measurements from the surface and bottom of the lower Snake River reservoirs near each dam. The data was constructed from figures in Karr et al (1998).

	Lower Granite		Little Goose		Lower Monumental		Ice Harbor	
Date	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
08/08/91	22.2 C	21.1 C	23.8 C	21.1 C	23.3 C	20.5 C	25.5 C	21.1 C
08/23/91	22.2 C	17.7 C	22.7 C	22.2 C	22.7 C	21.6 C	23.3 C	22.2 C
08/27/91	21.1 C	17.7 C	21.6 C	19.4 C	21.6 C	21.6 C	21.6 C	21.6 C

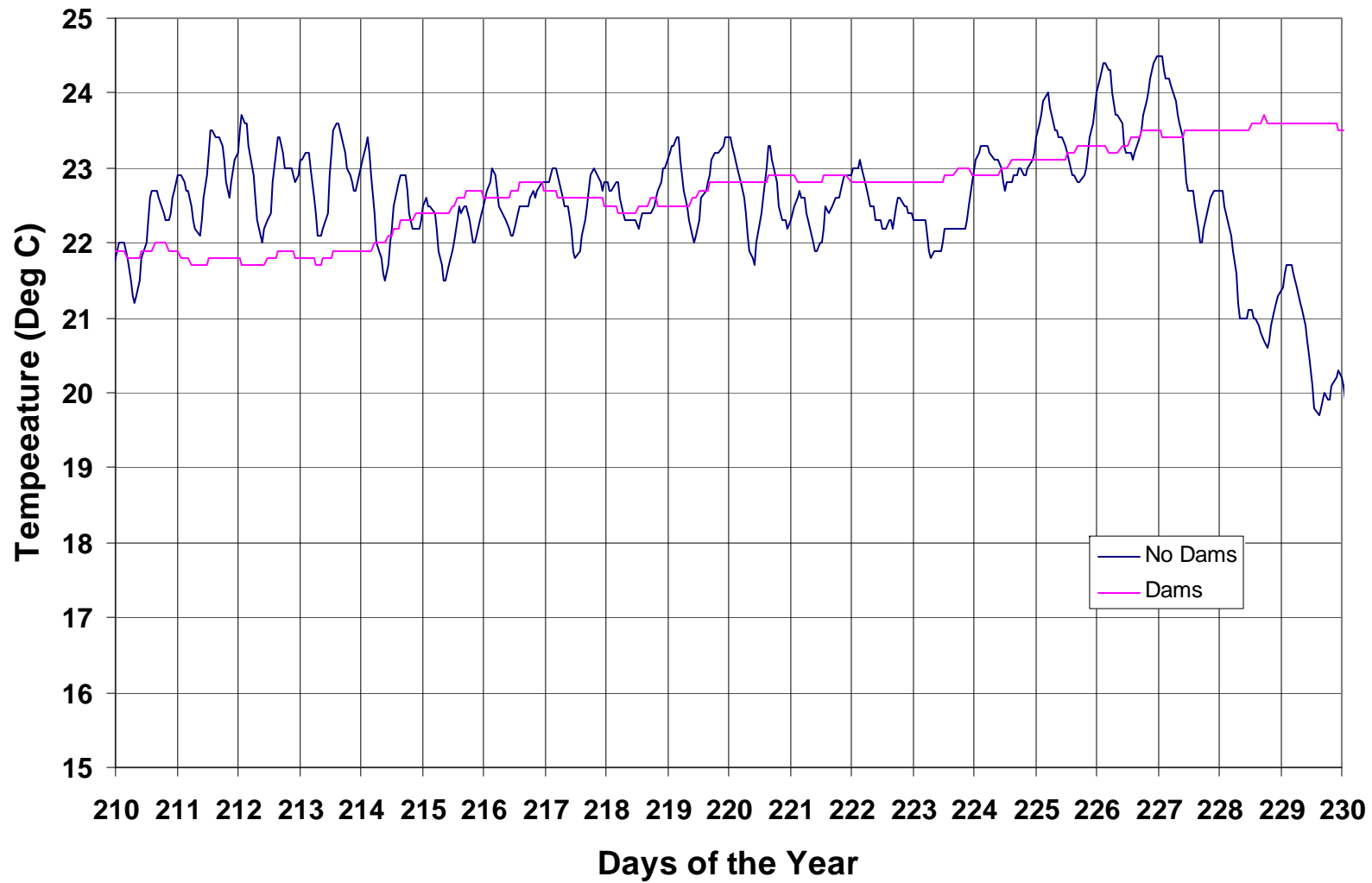
Table 3-6: Mean Monthly temperatures of fish ladders at the four lower Snake River Dams from 1991 through 1994. This figure is taken from Karr et al (1998). The temperature was reported by Karr in deg F and converted here to deg C.

		1991			1992			1993			1994		
Dam	Month	Tailrace	Lower	Upper	Tailrace	Lower	Upper	Tailrace	Lower	Upper	Tailrace	Lower	Upper
Ice	Aug	22.4	23.9		20.8	22.0	22.1	19.4	19.8	20.1	19.5	20.4	20.6
Harbor	Sep	20.3	22.3	20.1	19.7	20.9	19.8	19.1	19.8	19.8	20.0	20.4	20.2
	Oct	16.1	18.7	17.6	15.7	16.0	15.9				17.2	17.3	17.2
Lower	Aug	22.4		22.7	20.7	21.7	21.9	19.1	19.7	20.2	18.4	19.8	19.8
Monu	Sep	20.8		20.6	21.2	19.4	19.8	19.4	19.7	20.0	20.1	20.5	20.6
Mental	Oct	15.7		15.9		15.5	15.7					14.7	17.1
Little	Aug		22.6	22.8	21.1	22.2	22.3	19.1	20.0	20.0	18.5	19.5	19.8
Goose	Sep	19.3	20.1	20.2	18.9	19.2	19.1	20.1	20.6	20.5	20.6	20.8	21.0
	Oct	15.7	18.0	15.9	15.3	15.7	15.5				16.8	17.1	17.2
Lower	Aug	21.1	23.5	23.9	21.7	23.1	23.2	19.2	20.3	20.5	19.8	21.9	21.5
Granite	Sep	18.9	19.2	19.7	17.1	18.8	18.6	19.0	20.6	21.0	20.2	20.7	20.1
	Oct	15.9	18.1	16.8	15.3	15.8	15.8				16.3	16.4	16.6

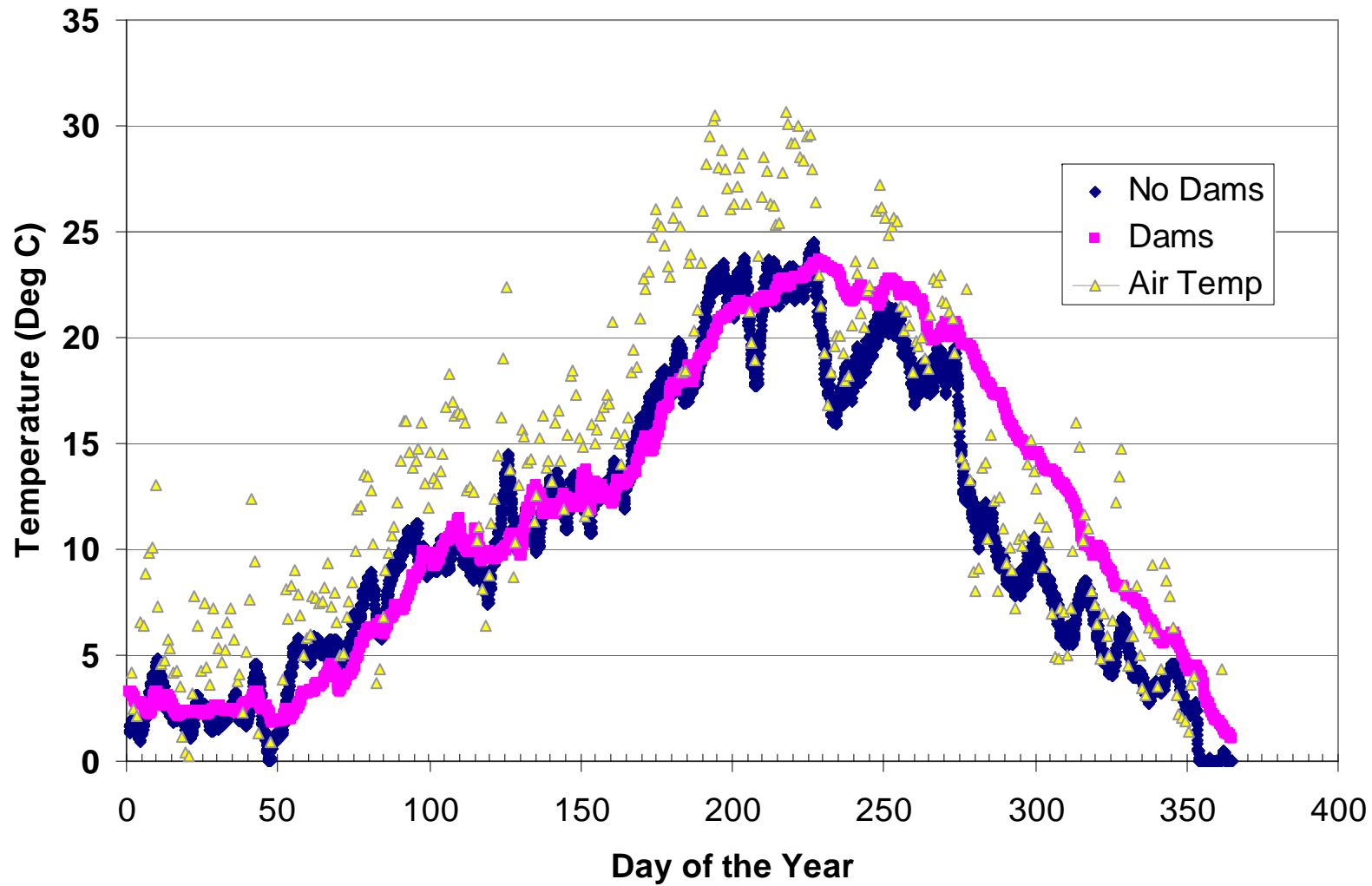
Figure 3-12. Simulated Water Temperature at Ice harbor Dam 1990 - Dams in Place and Dams Removed



Simulated Water Temperature at Ice Harbor Dam 1990 - Dams in Place and Dams Removed



**Simulations of Water Temperature at Ice Harbor Dam 1990 with Dams in Place
and Dams Removed Compared to Air Temperature at Lewiston, ID**



How has the Temperature Regime of the River Changed?

- **Longer periods with temperatures in the warm range for coldwater biota;**
- **Temperature gradients in the reservoirs resulting in warm surface water;**
- **Less fluctuation in temperature - daily and in response to meteorology.**
- **Loss of cold water refugia due to flooding of the alluvial flood plains.**

Effects of Temperature on Juvenile Steelhead

<u>Temp (C)</u>	<u>Effect</u>	<u>Reference</u>
12-13	Upper Limit of Optimal Range	Bell 1986
13	Smolting Inhibited	Zaug et al. 1972
15	Ability to out migrate reduced	Wedemeyer et al. 1980
	Fish stay in freshwater	McCullough 1999
16-17	Disease starts to be a concern	
	<i>Aeromonas liquefaciens</i>	Fryer & Pilcher 1974
	<i>A. salmonicida</i>	Fryer et al. 1976
	<i>Flexibacter columnaris</i>	Holt et al. 1975
19-20	Growth rate declines	Myrick & Cech 2001 (Rainbow Trout)

Effects of Temperature on Juvenile Steelhead

<u>Temp (C)</u>	<u>Effect</u>	<u>Reference</u>
20-21	Predation, optimum range for	Vigg & Burley 1991
	northern pikeminnow	Vigg et al. 1991
	walleye	Brown and Moyle 1981
	smallmouth bass	Koenst & Smith 1976
	channel catfish	Bell 1986
23	Disease more of a concern	(same as previous slide)
	Lethal range	Bell 1986